Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/697
SWITZERLAND
February 1964
Original: FRENCH

Confidential until official release during Conference

Abstract

Analogical study on the dynamic behaviour of the experimental nuclear power station at Lucens

by

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The behaviour of the Lucens station under variable conditions has been studied on a large-capacity analogue computer. The object of this work was to analyse the operation of the plant, to check its stability, to compare various modes of operation as well as different control systems, and finally to select the coefficients giving optimum performance.

In the first part the authors describe the control devices envisaged for the reactor, the primary loop, the steam generator and the turbo-alternator set. This equipment is devised so that the station can be controlled either from the reactor, to a predetermined power output programme (interconnected station), or from the distribution mains (isolated station). In the first case the nuclear output is fixed, whereas in the second case the reactor delivers the output demanded from it by the consumers. The circulation of coolant (CO_2) in the primary loop is always adapted to the nuclear output, so as to maintain a constant gas temperature at the reactor outlet.

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In a second part the bases of the calculation are set out. The capacity of the analogue computer, though considerable, was none the less limited, and it was necessary to adopt a certain number of simplifying assumptions. Only one steam generator is considered, instead of the two provided in the plant. The thermal models of the reactor and steam generator are subdivided into zones, for which the mean values are defined. The small time constants in relation to the behaviour of the whole plant are ignored.

The classical equations of neutron kinetics are introduced in their non-linear form, though only considering two imaginary groups of delayed neutrons. Other non-linearities are likewise preserved in the simulation of the reactor and of the primary loop. The models for the steam generator, the turbo-alternator set and the mains grid are described by linearized equations. The coefficients of the latter thus depend on the output level.

In the third part the authors show and comment on some examples of results obtained by simulation of the entire plant. The response of various characteristic values to small disturbances from a state of equilibrium at different output levels is recorded. With an interconnected station, for example, the disturbance consists of a variation in the set value of the power output, whereas for the isolated station a jump in the power absorbed by the mains is simulated. Various ways of regulating the steam generator are studied, also the individual influence of certain anticipatory signals.

It is confirmed that the station is capable of reacting rapidly to changes in the conditions demanded, and that the fluctuations of the controlled values remain within acceptable limits. In particular the gas temperature at the reactor outlet varies little, and the frequency variations observed in the isolated station are small.